

COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF INTERNAL AFFAIRS

THE  
PENNSYLVANIA  
GEOLOGICAL SURVEY

ADMINISTRATIVE REPORT

By  
GEO. H. ASHLEY



TOPOGRAPHIC AND GEOLOGIC SURVEY

1931

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GEOLOGICAL SURVEY

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ADMINISTRATIVE REPORT

By  
GEO. H. ASHLEY

Department of Internal Affairs  
James F. Woodward, *Secretary*  
Topographic and Geologic Survey.  
Geo. H. Ashley, *State Geologist*  
HARRISBURG, PA.

1931



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# TOPOGRAPHIC AND GEOLOGIC SURVEY OF PENNSYLVANIA

## ADMINISTRATIVE REPORT

BY GEO. H. ASHLEY, *State Geologist*

### SUMMARY

Pennsylvania always has been a leader in industry. To keep up this reputation of our Commonwealth means the constant building of improved plants and the promotion of new industries. Towns are growing or are seeking information in order to grow. State and local governments are building new or enlarged institutions. From these and kindred sources arise a constant stream of inquiries regarding the State's mineral resources and reserves, water supplies, topography, and geology.

On the other hand, the great output of minerals which has made Pennsylvania the peer of any country in the world as a mineral producer has led to the exhaustion of certain of these minerals in some places. Once thriving towns in the center of coal mining districts, for example, see their very life threatened by the exhaustion of the cheaply mined coal. The number of such towns is surprisingly large. Naturally these towns desire to know if their districts contain other undeveloped mineral resources on which new industries might be established.

To answer such inquiries the Commonwealth has established the Topographic and Geologic Survey.

The Topographic and Geologic Survey in the Department of Internal Affairs, is Pennsylvania's official organization for making a topographic and geologic map of the State, and for the study, testing, mapping, and description of the soils, rocks, mineral resources, and underground waters of the State. The Survey, with some interruptions, has worked and served the State for nearly 100 years. In a broad way the work of the present or Fourth Geological Survey falls into three major divisions—(1) information and publication; (2) geologic and mineral surveys; (3) topographic surveys.

*Information and Publication.* In the 10 years of its existence, the present Geological Survey of Pennsylvania is estimated to have saved the citizens of the State many times its cost in one phase of its work alone, that of preventing unwise mineral development or unwise investment in mineral promotions. Its positive service may be judged when it is considered that during its first 10 years, it has answered

about 10,000 inquiries made in person, and about 50,000 made by letter. That these answers have been of service is attested by a large file of "thank you" letters which range from one or two, to several a day. In addition to the information given at the Survey office is that given at conferences, such as those with Chambers of Commerce or other business organizations of towns seeking to draw new industries or hold old ones.

The Survey has published 25 reports including over 4,000 pages, with many maps and illustrations. Two of these have required a second edition, and one, which has been out of stock several years, has sold for as high as \$10.00 a copy by secondhand book dealers. In June 1930, eight additional reports are being printed, or have been submitted for printing, and a new State geologic map has been submitted for engraving. Twenty-four other reports are practically ready for publication or nearing completion, and many other projects are well started. These, when issued, will probably much more than double the material already published. One hundred mimeographed bulletins, ranging from 3 to 28 pages each, have been issued to give information in advance of printed reports.

The State Geologist and other members of the Survey have responded to many calls for aid in dealing with geologic or water supply problems encountered by other departments of State government, or by municipalities, or in presenting facts at hearings, for river improvement, and in similar matters. The State Geologist has given many public talks each year on the geology and mineral resources of the State, and he and other members of the staff have prepared many articles for the technical press on the mineral resources and geology of the State.

*Geologic surveys.* A second line of the Survey's work, of equal or greater importance, is the conduct of the geologic field surveys. This field work may be the mapping of the rocks in a definite area, or the study of the occurrence of some mineral. Since 1919, the Geological Survey has made more or less detailed studies of the following mineral resources: coal, oil and gas, oil shale, cannel coal, clay and clay products, building stone, limestone, slate, silica refractories, glass sand, molding sand, sand and gravel, lead and zinc, iron, feldspar, vein quartz, underground waters, soils, and other mineral resources. Two counties have been surveyed and reports prepared. Fundamental scientific studies have been made of a number of geologic problems.

Detailed geologic mapping to be published on the topographic base maps on a scale of 1 inch equals 1 mile began in 1899. Up to 1919 the U. S. Geological Survey had published reports on 35 quadrangles; of these 25 were studied in cooperation with the State, which paid half of the expense of the field and office preparation of the reports, and



10 were by the Federal Survey without the cooperation of the State. A large amount of additional work, as yet unfinished, has been done by the U. S. Geological Survey. Since 1919, the U. S. Geological Survey has published folios on 4 quadrangles, and the State Survey corresponding atlases on 6 quadrangles. At the present time, the Federal Survey has geologic reports on 8 quadrangles in press, and the State Survey two. The Federal Survey has 5 and the State Survey 2 quadrangle reports ready, or nearly ready, awaiting funds for printing. Surveys are in progress on 13 quadrangles, 3 by the State alone, 6 by the Federal Survey alone, and 4 in cooperation.

*Topographic surveys.* The third major activity of the Survey, which has absorbed about one-third of its funds, is that of topographic mapping. At this point it is only necessary to give a brief outline of the whole situation as follows:

The area of the State is 45,126 square miles. Topographic mapping to 1919 had covered 25,400 square miles or 56.3 per cent of the State. From 1919 to 1929 inclusive 11,344 square miles or 25.1 per cent of the State was mapped, making a total of 36,744 square miles of the State mapped to date, or 81.4 per cent. This leaves 8,382 square miles yet to be mapped. At the present rate, it will require eight years to complete the topographic mapping of the State.

## HISTORY

The Geological Survey of Pennsylvania is approaching its 100th anniversary. In a sense, the Survey dates back to February 25, 1832, when seven men of science met in Philadelphia and organized the Geological Society of Pennsylvania for the promotion of a general geologic survey of the State, and to obtain "an exact knowledge of the mineral resources of the State." The Society memorialized the legislature, asking for assistance to the extent of \$27,000 "to make a topographic, geologic and mineralogic survey of the State," etc. It was, however, four years later in the spring of 1836 that the State legislature passed an act appointing a Survey of the State and authorizing an annual expenditure of \$6,500 for five years. The appropriation was subsequently increased.

It is not necessary for our present purpose to follow the fortunes of the Geological Surveys of Pennsylvania, except to point out that, including gaps from 1843 to 1851, from 1855 to 1874, and from 1895 to 1899, the Geological Survey of Pennsylvania has been in existence for nearly 100 years. The work of the First Survey led to the publication of six small annual reports, and later of two ponderous volumes of 1,631 quarto pages. The Second Survey, established in 1874, closed its work in 1895, having published reports that fill about 10 feet of library shelving, besides a State map, and a grand atlas.

In 1899, the State provided for a Topographic and Geologic Survey Commission, and began, in cooperation with the U. S. Geological Survey, systematically to map the topography and remap the geology of the State on the basis of the new, large scale, topographic maps. It was at this time that the present State Geologist first became acquainted with the geology of the State, having charge of the work in Pennsylvania from 1904 to 1908, at which time the State reestablished a State Geologic Survey and discontinued cooperative geologic work, though cooperative topographic work continued. The reports of the geologic work were published by the U. S. Geological Survey as "folios," of folio size,  $21\frac{1}{2} \times 18\frac{1}{2}$  inches, and as bulletins of octavo size. Between 1899 and 1919 the State Survey published 18 reports, mainly administrative or statistical. In 1919 an act abolished the old State Survey which for lack of funds had been inactive for several years and established the present Survey. The writer was appointed State Geologist, and took office September 1, 1919.

*The Present Survey.* The act establishing the present Survey, set forth its duties as follows:

"Section 4. The bureau shall undertake, conduct, and maintain the organization of a thorough and extended survey of the State for the purpose of elucidating the geology and topography of the State.

"The survey shall disclose such chemical analysis and location of ores, coals, oils, clays, soils, fertilizing and of other useful minerals, and of waters, as shall be necessary to afford the agricultural, mining, metallurgical, and other interests of the State a clear insight into the character of its resources. The survey shall also disclose the location and character of such rock formation as may be useful in the construction of highways or for any other purpose.

"The bureau shall collect such specimens as may be necessary to form a complete cabinet collection of specimens of the geological and mineral resources of the State. The State Museum shall be the repository of such specimens.

"The results of the survey shall be, with the results of previous surveys, put into form convenient for reference.

"Section 6. The bureau shall collect copies of the surveys of this and other States and countries, and shall digest the information therein contained, to the end that the survey hereby contemplated may be made as thorough, practical, and convenient as possible.

"Section 8. The bureau shall avail itself as fully as possible of the information, maps, and surveys, possessed by citizens and corporations of this State, relative to the geology and topography of the State.

"All the facts, of whatever nature, obtained by the survey shall be considered public property, and any concealment or speculative use of the same is prohibited."

The other sections deal with the internal organization and conduct of the Survey.

Under this broad charter, the Geological Survey has considered itself as previously stated, the State's officially constituted "Survey" for all matters dealing with the geology and mineral resources of the Commonwealth including its topography and soils, and its underground waters. As noted, it is directed and empowered to make such analyses

and tests as are necessary to "disclose the character of its resources."

In several instances, either at the solicitation of a cooperating agency, or because the need was apparent and no other qualified State agency existed, the Survey has extended its geologic studies to cover mining methods, preparation and use of mineral resources. In addition, the State Geologist having in 1923 been made chairman of the board of Maps and Surveys, the Survey has taken a leading part in the preparation of base maps of Pennsylvania for use by all departments. In 1927 the State Geologist was appointed a member of a Commission on Barrier Pillars in the bituminous coal mines. Later he was made secretary of the Commission, and this again brought the Survey into contact with the mining problems of the State. Aside from these special calls from cooperating agencies for undertaking studies of the mining, preparation and use of mineral resources, no small part of the inquiries coming to the Survey relate to technical matters on mining, quarrying, drilling, and so on.

However, now that the School of Mineral Industries at State College has been provided with adequate quarters and facilities, the Survey hopes to turn over to the college such phases of this work as can be handled by the college with greater economy, retaining to itself, in accordance with its charter, all studies requiring field investigations, and the reports on those investigations.

## ORGANIZATION

For purposes of budgeting and cost accounting, the work of the Survey has been divided into six major subdivisions, entitled (1) General Operations; (2) Topographic Surveys; (3) Geologic Surveys; (4) Mineral Surveys; (5) Ground-water Surveys; (6) Soil Surveys.

### GENERAL OPERATIONS

This branch of the work is divided into—(1) Administration, (2) Information Service, and (3) Publication.

*Administration.* Administration includes the planning and direction of the work, making budgets, cost accounting, filing, obtaining and care of office and field equipment and supplies.

*Information Service.* Under Information Service falls first, the collection of a library in accordance with a clause of the Survey's charter: "The bureau shall collect copies of the surveys of this and other States and countries, and shall digest the information therein contained to the end that the Survey hereby contemplated may be made as thorough, practical and convenient as possible." Starting with next to nothing, except the use of several thousand volumes belonging to the State Geologist, the State Geological Survey library now has about



4,000 volumes including unbound volumes of the scientific and technical journals, and the reports of the leading Geological Surveys of the world. This library is available during office hours to any one seeking geologic information.

The Survey has 3,000 to 4,000 photographs, mostly post card size, made by its geologists in their field work; also several hundred lantern slides. Lack of suitable space has prevented the collection of many mineral specimens, except of such material as was needed for immediate study.

Under Office Service is charged the time devoted to answering letters, and the inquiries of those who visit the office in person. Many of those who do come to the office could hardly have been answered satisfactorily by letter. Persons often stay several hours or days studying maps and reports, or asking questions on various phases of the subject at hand. Among office visitors are many engineers and mining geologists seeking very definite information, not alone on the geologic phases of the subject, but quite as often on the economic and financial problems involved in some proposed development. Some callers bring specimens for identification, others are interested in the possibility of the occurrence of valuable minerals under their land. Other inquirers are seeking a particular quality of limestone, sandstone, shale, or other rock needed in their business or in a projected new development. Often it is a combination of rock qualities that is sought, or a place where several raw materials of definite character can be brought together. Those interested in the development of oil and gas, especially in wild-cat territory or worse, form a large group. Water supply problems are real problems to many. Indeed in many instances the success or failure of an enterprise depends upon finding water of proper quality or in sufficient quantity. Many calls come from students, from grammar school to college, asking for information regarding the various mining industries. Individual inquiries cover thousands of subjects, from elevations of particular places or areas, to the explanation of ice caves, ringing rocks, will-o'-the-wisps or other phenomena; from production of a certain mineral for a certain year, to the age of the mountain top peneplain; from the coal beds under a certain farm, with their depth, thickness and quality to the origin of a lake in Pike County.

Under Outside Service fall a variety of services. Survey members may not give what would amount to professional services to individuals, but do respond to calls from cities, or where some problem affects a large number of people. A recent illustration of this is the part taken by the State Geologist and other members of the Survey in testifying at a hearing on a proposed river improvement. Definite figures of available tonnages of coal and other minerals adjacent to the river were given to the army engineers, figures which in large measure re-

vealed the basis for future mineral tonnage on the improved river. Many calls come from Chambers of Commerce and similar bodies with reference to available mineral resources tributary to their territory. The exhaustion of the more readily mined beds of coal or other minerals in many districts leads to inquiry as to the existence of other minerals of value that might serve as a foundation for new enterprises or take the place of those now declining. This phase of the work is one of increasing importance.

The State Geologist has given talks on the mineral resources and geology of the State in nearly 50 cities in Pennsylvania, ranging from one to a dozen or more talks in each, not counting the large number given in Harrisburg. These have included cities from Philadelphia and Stroudsburg on the east, to Erie, Pittsburgh and Uniontown on the west. Many talks have been given in Harrisburg to visiting groups of people, especially to groups of students on geologic excursions; also a number of talks over the radio. In a few instances the State Geologist has led groups on field excursions. The members of the Survey have written many special articles that have been published in the technical and scientific journals. The State Geologist has written 29 such articles for 16 journals; Mr. Stone 25 for 8 journals, and other members a fewer number. This is in addition to scores of newspaper stories, press notices, etc. Many conferences have been held with representatives of Chambers of Commerce and similar bodies regarding the work of the Survey in their districts, and the outlook for increased mineral production.

In a professional way the State Geologist has been asked to serve on the councils or governing boards of the Geological Society of America, Society of Economic Geologists, Pennsylvania Academy of Science, American Association for the Advancement of Science, and other scientific and technical societies, and on important committees of those societies. In 1926-1927, he served as vice-president of the American Association for the Advancement of Science, chairman of Section E. He has been an active member of an International Committee on Coal Classification, on committees of the American Institute of Mining and Metallurgical Engineers, on mining geology, on ground movement and subsidence, and on nonmetallics. The Survey has cooperated with the State Chamber of Commerce on a number of projects and in publicity matters. The State Geologist has acted as judge in a number of State-wide first-aid contests. He is a member of a committee on excursions for the International Geological Congress in the United States in 1932, and was a delegate from Pennsylvania to the International Geological Congress in Madrid in 1926. He is a member of a committee planning the scientific exhibits at the Chicago Exposition of 1933.

Under Cooperative Service is charged time and expense of work for



other departments or bureaus. Such service always has the first call on the Survey. The scope of this work may be indicated by a list of some of these cooperative services.

Of largest importance is the making and supplying of the topographic maps which are much used by many of the departments. Related to that has been the preparation and supplying of base maps, ranging from a new engraved map 30" x 54" on the scale of 6 miles to the inch, through intermediate sizes down to 5" x 8" cards. One map has only county lines and names, another shows streams, towns, etc.

Among other major projects may be mentioned several months' work with three field parties locating quarry sites for road material for the Highway Department.

Collection of material and data for use on the Memorial Bridge at Harrisburg.

Furnishing the Governor's office with data on Giant Power, coal and other problems.

Preparation of an exhibit on Mineral Resources for the Sesqui-Centennial Exposition at Philadelphia.

Field examination of proposed site of new Eastern Penitentiary, for building stone and other mineral resources, water supply, etc.

Advising the Securities Commission in the Department of Banking on cases involving mineral land.

Preparation of articles on geology and mineral resources for Pennsylvania School Journal, Department of Public Instruction, and conferences on science courses.

Among minor cooperative projects, many of which require some field work, are location of water supplies for public institutions; for many departments especially for the Department of Health, to determine avenues of contamination, disposal of mine wastes, phenol wastes, etc. For the Department of Forests and Waters, consultation on dam foundations and drainage areas, relation of forest soils to bedrock, etc. Information needed on valuation of coal lands for taxing purposes, consultations regarding proposed laws affecting minerals. Indeed, hardly a week passes that there is not some minor matter referred from Departments of the State government to the Survey for information.

On the other hand, the Survey wishes to acknowledge its indebtedness to other departments and bureaus, especially to the Departments of Highways and of Mines, which have most generously and freely furnished surveys or cooperated in obtaining desired data about the mines.

The State Geologist has served as secretary of the Pennsylvania Geographic Board since its creation, as a member of the Giant Power Board, of the Sesqui-Centennial committee, and of the Bituminous Coal Mine Drainage Board.

*Publication.* Publication forms the third division of the General Operations branch of the work. This includes the typing, editing, and proof reading of text. Because of their highly technical nature, the manuscripts of the Survey require very careful editing. More than that, the Survey has set itself a high standard in the character of its reports. It is fortunate in having Mr. Stone, a geologist who is also a very capable editor. Many reports require a large amount of rearrangement or condensing at his hands. In the matter of illustrations, the Survey has set itself an equally high standard in the preparation of maps, diagrams, and miscellaneous drawings. A complete list of the Survey reports occurs in the back of this report (See Appendix A).

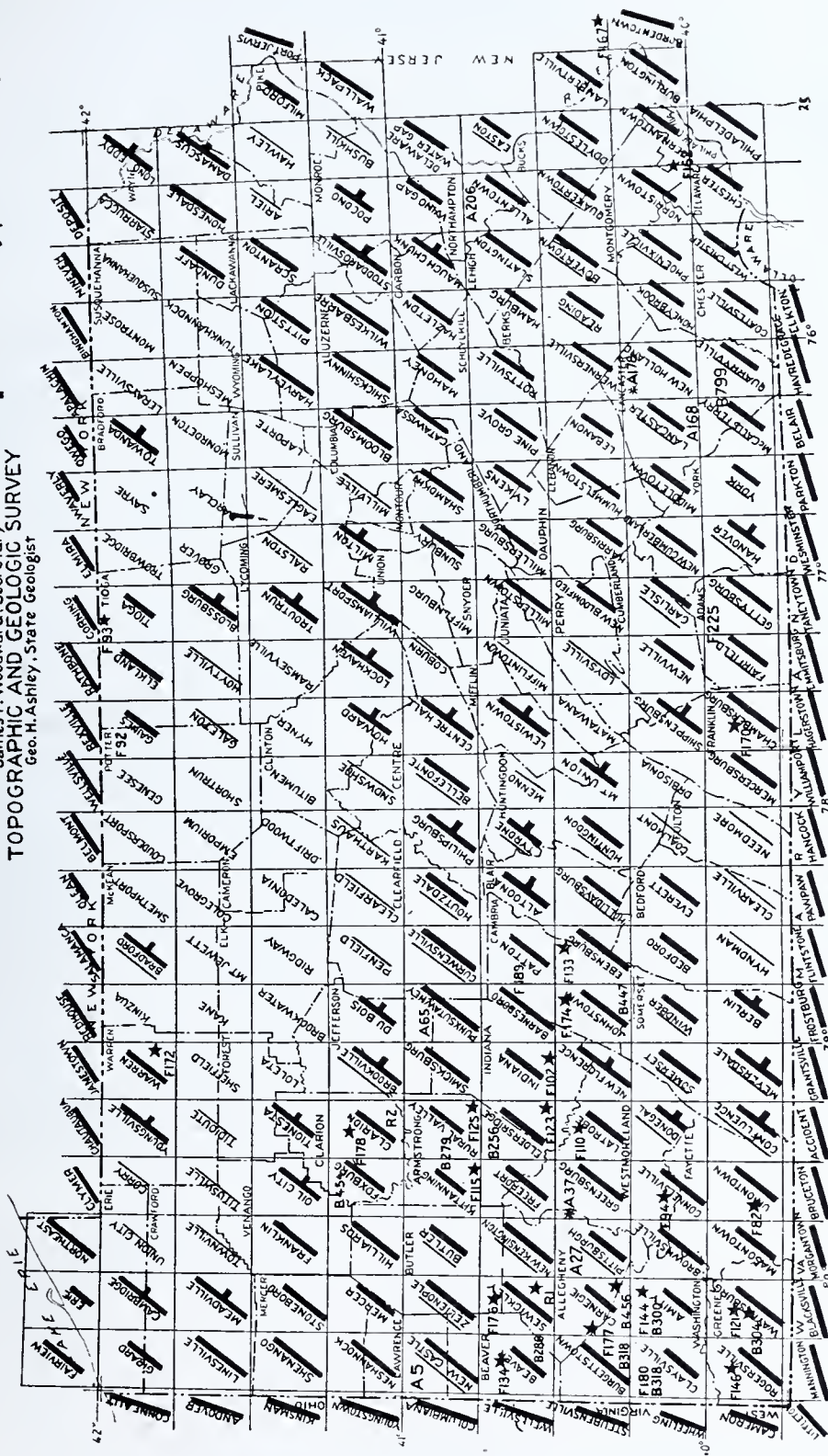
## TOPOGRAPHIC SURVEYS

The accompanying map of Pennsylvania shows the progress of topographic mapping. Quadrangles on which there is a heavy line below the name can be obtained in engraved form from the U. S. Geological Survey. Those on which there is a light line below the name have been surveyed or are being surveyed, but are not yet available in engraved form.

The topographic mapping is done by the Topographic Branch of the U. S. Geological Survey on a 50-50 basis as regards cost of field and office work. The State determines where the work is to be done, and the Federal Survey does the work. In the past the engraving and printing of these maps has been done wholly at the expense of the Federal Survey. Recent action by Congress indicates that in the future the cooperating States will be required to pay half the cost of the engraving and printing as well as of the mapping.

Careful consideration has been given to topographic mapping by airplane. At the present time such mapping is highly successful but costs much more per square mile than ordinary methods. The unmapped area of the State is mainly in wooded country with small population and little industrial life. It has therefore been decided to continue by the present methods until the whole State shall have been mapped. When that is done, consideration may be given to airplane mapping of areas of dense population and large industrial development. These areas were mapped many years ago (1875-1900), and revision is needed because there have been many changes in towns, roads and buildings since that time. Then too, airplane mapping lends itself to the production of larger scale maps than the present method. It was hoped in 1919 that funds would permit the completion of the first mapping of the State by present methods before this time, and that airplane mapping of metropolitan districts could then be undertaken. At the present time topographic mapping costs about \$50 a square mile or about \$11,250 a quadrangle, of which as stated, the State pays one-half and the Federal government one-half. Airplane mapping is estimated to cost from \$100 to \$150 per square mile or more.

*Making a topographic map.* The topographic maps of Pennsylvania are all on the scale of  $\frac{1}{62,500}$  that is one inch of the map represents 62,500 inches in nature, or almost 1 mile (63,360 inches). The present maps represent an area of 15 minutes or  $17\frac{1}{2}$  miles from north to south, and 15 minutes or  $13\frac{1}{2}$  miles from east to west. The length from north to south is the same for all quadrangles, but due to the converging of meridians at the poles, the width narrows towards the north, so that each map is slightly narrower across the north end than



Under name, Topographic field work completed or in progress.  
Under name, Engraved map available 10 cents each.  
Over name, Geologic field work completed or in progress.

Reports by number, Pennsylvania Geologic Survey.  
\* Temporarily out of stock.  
\* Stock exhausted, obtainable only from secondhand book dealers.

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across the south end. The difference on the map in the latitude of Pittsburgh is  $\frac{64}{1,000}$  inches. It is because of this slight departure from having equal sides and angles that the areas are called quadrangles.

Having selected a quadrangle, the first step is the accurate location of a number of prominent points in or close to the quadrangle. This is done by making astronomical observations on the stars and very accurate triangulation on other points whose positions have previously been determined. Poles carrying flags are set up at selected points, which are usually on the highest land to be found. This work is called the primary triangulation. By it the exact position of the selected hilltops in the quadrangle is obtained.

The next stage in the mapping is the secondary triangulation and the primary traverse and leveling, by which many intermediate points are located. The secondary triangulation is carried on by the use of large plane tables set up first at the points of the primary triangulation.

In the meanwhile other parties are running primary traverse and level lines. The traverse lines start from points previously determined or known. Measurements are commonly made with a steel tape to which a spring balance has been attached, and measurement is made while a certain pull is given to the tape as registered on the spring balance. The survey is always made from one known point to another, or on a closed circuit, that is a line that is continued until it returns to the point of starting. When plotted, such a circuit must close within a small fraction of a foot. In the same way level lines or circuits are run to establish the elevations along these lines at a large number of points.

When this precise work has been done, lines are run along all of the roads not previously traversed, along ridges, stream valleys, and wherever else it may be necessary in order to cover the map with a close network of lines and levels. This work may be done with a stadia. In leveling work, the elevation of a road at each rise or dip is commonly shown by a number painted on a fence or nearby rock for the convenience of the topographer.

A highly trained topographer now takes the map prepared with all these lines and points carefully adjusted, and fills in the topography and all culture not previously represented. When he has finished, he has drawn a map that by means of contour lines or lines of equal elevation shows within a few feet the exact elevation of every point in the quadrangle, the shape and slope of each hill and valley, the streams, canals, railroads, houses, towns, factories, and other projects commonly found on the map.

When this is accurately engraved, the result is one of the beautiful



topographic maps that the Federal Government sells for 10 cents, which merely covers the cost of paper and press work.

A new base map of Pennsylvania, on a scale of 6 miles to 1 inch, was engraved in 1928. It is in two colors, black showing county and township boundaries, railroads, and hundreds of place names, and blue for streams and lakes. This map was compiled by the chief cartographer of the U. S. Geological Survey from existing topographic maps and other data.

## GEOLOGIC SURVEYS

*Making a geologic map.* The field methods used in Pennsylvania follow those developed by the U. S. Geological Survey with its large personnel and its half century of experience, though as a rule we give more attention to the rocks and minerals likely to be of economic value.

In the oil and gas regions of the State where great accuracy is necessary in determining the rock structure, much of the work has to be done with telescopic alidade and stadia rod. In other areas the hand level and barometer are used to determine elevations at a distance from those marked by the leveling party. The geologist must cover the area with the same exactness as the topographer, and in addition make detailed studies of the rocks and examine mines, quarries, and other development work.

Each quadrangle presents its own type of problems. It is usual to assign to an area men who have had special experience in the problems to be met there. Many quadrangles present several major problems of quite different type. In such a case one man may be made responsible for the stratigraphy, structure, and areal mapping of the rocks, while one or more specialists may investigate the coal, clay, oil and gas, etc. In this way all problems receive adequate treatment, including data on mining or quarrying methods, uses of any economic minerals being developed, and the collection of samples for analyses or tests.

Where the rocks are extremely regular and the structure simple it may be possible to map the geology with much accuracy if the geologist passes within half a mile of every point in the quadrangle. In other areas, the geologist may spend days working over a 40-acre tract, where it may be possible to work out the relations or structure of the rocks.

In the end the geologist's map and notes contain a record of every exposure of rock he has seen, its exact location on the map, with notes on its character, elevation, lay or dip, fossils (if it contains any), and anything else that might be of interest or value in working out its relations to other rocks. His map shows the boundaries of the different rock formations, the location of mines, quarries, wells, and other points of interest.

Because of the heavy mantle of soil and vegetation it is necessary for the geologist to get much of his information from obscure sources. The character of the soil or of the rocks in the soil is often the only indication of the nature of the underlying rock. Rocks exposed by the roots of overturned trees, on groundhog mounds, or in the gutters of roads must be studied. In some hilly areas, the stone fences may be the only evidence of the character of the underlying bed rock.

Besides mapping the rocks at the surface, the geologist collects the records of wells, drill holes, and mine shafts, as a guide to the geology underground. Samples are taken of coals, clays, limestones, and sandstones, using modern methods which require cutting a uniform trench across the bed, saving an equal quantity from all parts of the cut, mixing and quartering the cuttings down to a few pounds. These samples are analyzed or otherwise tested in a Federal, college, or commercial laboratory. The Survey has no laboratory, for it does not feel justified in maintaining the necessary men and equipment.

Having completed his field mapping, the geologist next plots his notes on engineering paper in such a way that he can trace the position of any bed to several thousand feet under the surface. In his report this material is published in the form of a structure contour map, or cross sections.

In order to judge what any particular bed, such as a coal bed, may be like under the surface at any point, it is necessary to study the characteristics of that bed from place to place. If the rock layer which we wish to know about is a sandstone, shale or limestone, it helps greatly in judging what its character may be under the surface if we know from which direction the material came. A sandstone near the old shore line may grade into a shale farther off shore, and that in turn into a limestone still farther off.

It is especially necessary in judging of the presence, probable richness and depth of ores, oil and gas, and some other deposits that the geologists be familiar with all that has been learned about similar deposits all over the world. It is here that a wide personal experience counts for much, and it is for this reason that the geologist requires a large library and opportunity to keep in touch with new discoveries in his line.

*Topographic and Geologic Atlas.* The Survey is making an atlas of the State, composed of a topographic and geologic map of each quadrangle. The topographic map is the base for the geologic map. Plate I shows the progress of geologic mapping in the State. A geologic map of a quadrangle is intended to disclose the succession of rocks underlying the area, their character and thickness, and the extent of each bed. In some areas the position and depth of a principal bed below the surface is shown. The geologic atlas should also disclose

the presence, character, extent, quality, and quantity of any mineral resources that may occur in the area.

It is upon this type of mapping that in the end our detailed knowledge of the geology and mineral resources of the State depends. Where such mapping has been completed, the Survey is prepared to answer any detailed questions on the geology and mineral resources, and any one with a fair knowledge of geology can answer his own questions from the published report.

Since 1919 the field work has been completed and the following parts of the Topographic and Geologic Atlas of the State have been published by the State Survey.

- A5 New Castle, by Frank W. DeWolf.
- A27 Pittsburgh, by M. E. Johnson.
- A37 Greensburg, by M. E. Johnson.
- A65 Punxsutawney, by Geo. H. Ashley.
- A178 New Holland, by Anna I. Jonas and George W. Stose.
- A206 Allentown, by B. L. Miller.

The U. S. Geological Survey has meanwhile published similar reports, on four quadrangles:

Folio 225, Fairfield and Gettysburg quadrangles, by Geo. W. Stose and F. Bascom.

Bulletin 799, McCalls Ferry-Quarryville District, by E. B. Knopf and A. I. Jonas.

The following list shows the status of unpublished geologic work on the quadrangles of Pennsylvania as of January 1, 1930. Some of this work was started or done before 1919 by the U. S. Geological Survey without cooperative aid from the State.

Coatesville-West Chester Folio: Maps and sections approved for transfer to stone. Text approved for printing (U. S. G. S.) F. Bascom, E. B. Knopf, A. I. Jonas.

Somerset-Windber Folio: Maps engraved, approved for transfer to stone. Sections in plate proof; text in galley proof, ready for page proof. (U. S. G. S.) G. B. Richardson.

Hollidaysburg-Huntingdon Folio: Maps in plate proof; text mostly edited. (U. S. G. S.) Chas. Butts.

Bellefonte Folio: Completed and practically ready for publication by Federal survey. E. S. Moore.

Lancaster Quadrangle: Being published by the State Survey as Atlas No. 168. Text in galley proof. Maps being engraved. A. I. Jonas and Geo. W. Stose.

New Kensington Quadrangle: In course of publication as a bulletin by the Federal Survey. Geo. B. Richardson.

New Holland Quadrangle: Preliminary edition published by State Survey as Atlas No. 178, but edition destroyed by fire. Needs addition of structure sections, etc., for republication. A. I. Jonas and Geo. W. Stose.

Quakertown-Doylestown Quadrangles: In course of publication as a bulletin by Federal Survey. F. Bascom, E. T. Wherry, E. B. Knopf, A. I. Jonas.



Tyrone Folio: Field work complete and preliminary map drawn but boundaries will have to be adjusted to new topography. Text partly written. (U. S. G. S.) Chas. Butts.

Zelienople-Butler Quadrangles: Field work completed; report being prepared for publication as a bulletin by the Federal Survey. Geo. B. Richardson.

Middletown Quadrangle: Field work completed; maps and sections drawn; text complete except description of diabase. Was finished last spring for report to be published by the State Survey. A. I. Jonas, Geo. W. Stose.

Hanover-York Quadrangles: Field work well advanced; report to be published by State Survey. A. I. Jonas, Geo. W. Stose.

Reading-Boyerstown: Nearly finished. F. Bascom, E. T. Wherry, E. B. Knopf, A. I. Jonas.

New Cumberland Quadrangle: Triassic boundary and pre-Triassic rocks surveyed by Federal Survey and map prepared; text in preparation; to be combined with Triassic geology by the State Survey for publication by the State. M. H. Bissell, Geo. W. Stose.

Honey Brook-Phoenixville Folio: Needs some field work on Triassic before completion. Text and map need some revision. (U. S. G. S.) F. Bascom.

Slatington Quadrangle: Preliminary map prepared, but requires further field work before acceptable for publication. (U. S. G. S.)

Carlisle Quadrangle: Preliminary draft of map prepared; should be combined with Newville Quadrangle in Folio or State report. Geo. W. Stose.

Curwensville Quadrangle: Field work completed, report nearing completion. To be published by State Survey. Geo. H. Ashley.

Houtzdale Quadrangle: Field work completed except for some revision, report in progress; to be published by State Survey. Geo. H. Ashley.

Meyersdale Quadrangle: Field work three-quarters completed. Will be completed in 1930. J. D. Sisler.

Bradford Quadrangle: (Mainly economic study). Field work nearly completed, text well along. C. R. Fettke.

Freeport Quadrangle: Completed and ready to be published by State Survey. H. H. Hughes.

Hummelstown, Lebanon, Wernersville Quadrangles: Preliminary map prepared; topographic map of Lebanon quadrangle too inaccurate for use. Geo. W. Stose and A. I. Jonas.

Pottsville, Pine Grove, Hamburg, Mauch Chunk and Wind Gap Quadrangles: Reconnaissance and preliminary map prepared of Martinsburg shale and contact with Medina. Geo. W. Stose.

Allentown, Easton, and Delaware Water Gap Quadrangles: Preliminary maps prepared; further field work required.

Brookville Quadrangle: Field work started 1929. H. H. Hughes and C. K. Graeber.

*County Reports.* Detailed geologic work may also be done by counties. A report on Adams County by George W. Stose is ready to be published by the State. Greene County was covered many years ago by folios published by the U. S. Geological Survey, but these have long been out of print, and there has been a very large development of coal mining and drilling for oil and gas since that time. A new report therefore on Greene County has been prepared by R. W. Stone and is ready to print.

Work has been started on a report of Fayette County by Stanley H. Catheart, assisted by Forrest T. Moyer.

*General Geology.* In addition to these detailed areal surveys many geologic problems have been studied. These fall mainly into two

groups—studies in surface geology and glacial history, and studies in stratigraphy.

During the summers of 1921-24 H. L. Fairchild of the University of Rochester, a specialist in glacial geology who had just completed a study of the glacial history of the Susquehanna basin of New York, began a study of the Susquehanna basin in Pennsylvania. His work revealed many new facts and many new problems, especially south of the Wisconsin glacial moraine. This led to a cooperative agreement with the U. S. Geological Survey through which Frank Leverett, an internationally-known glaciologist of that survey, spent two summers in Pennsylvania mainly in the middle Susquehanna area, but also in the Delaware Valley and the glaciated areas of western Pennsylvania. Leverett's work showed that the middle Susquehanna Valley as well as other areas have a very complicated history as revealed in several drift sheets of different ages, in river benches and gravels at elevations above the river ranging from 30 to 500 feet. In the endeavor to find the relation between these river terraces and the Atlantic coastal-plain terraces an additional cooperative agreement was entered into with the U. S. Geological Survey which provided for a study of the lower Susquehanna and adjoining areas by M. R. Campbell of the Federal Survey. The work of these specialists has been supplemented by detailed areal mapping and analysis of the gravel deposits and river benches by M. N. Shaffner and F. T. Moyer of the State Survey.

During the summer of 1930 detailed studies bearing on these general problems were made in the Wyoming Valley by Harry Itter of Lafayette College and in the Delaware Valley below the Water Gap by Freeman Ward of Lafayette College. All of these several studies will be published together, with an introduction by the State Geologist.

The broader physiographic features of the State, especially the peneplains, their ages, etc., have been studied extensively by the State Geologist, George W. Stose, F. Bascom, and E. B. Knopf.

The stratigraphy or succession of the rock beds and the structure or relative position of the rocks in the State have been studied by E. O. Ulrich, Charles Butts, George W. Stose, and David White of the U. S. Geological Survey, and by D. C. Renick, Bradford Willard, Frank Swartz, and Anna I. Jonas of the State Survey. The problems range from those of narrow interest to others affecting considerable areas. Modern stratigraphic and structural work is more detailed than that done by earlier Surveys. For example, the Second Geological Survey treated the Helderberg limestone as a unit. Indeed it and the underlying Tonoloway (Bossardsville?) limestone were commonly combined as a single unit. Today the Helderberg is recognized as made up of the Keyser limestone, Coeymans limestone, New Scotland limestone, Becraft limestone, and Shriver chert. The tracing and identification



of these from place to place is an intricate problem. In the same manner Formation II (Cambro-Ordovician limestone) of the Second Geological Survey, mapped as a single unit, is today subdivided into 19 mappable units having distinct characteristics and values. There are still in the State, many formations from 1,000 to 6,000 feet thick that need to be subdivided, in order to correlate them more accurately.

About 30 caves in the State have been examined and maps made of the underground galleries in many of them. A report by Mr. Stone on "Pennsylvania Caves" has been widely accepted.

A new geologic map of Pennsylvania, to go on the new base map, has been prepared in cooperation with the Federal Survey. It includes much geology not previously published. This new map has been several years in the making and is now being engraved.

Two general papers by the State Geologist on the geology and mineral resources of Pennsylvania are about ready for the press; one is a popular account or "Syllabus of the Geology and Mineral Resources of Pennsylvania;" the second, a semipopular description of the "Rocks of Pennsylvania." There has also recently been prepared a 16-page brochure on "The Resources of Pennsylvania in a Nutshell" for insertion in letters. The State Geologist has given considerable attention to a simplified stratigraphic time scale for use in the Survey reports.

## MINERAL RESOURCES

The major interest of the present Survey since its establishment in 1919 has been a State-wide study of its many mineral resources. These will be taken up by subjects in order:

### *Anthracite:*

1. A study of "river coal" by C. W. Webbert to determine its amount, the quantity being recovered and the outlook for the future was made in 1919 when a prolonged strike in the anthracite fields drew attention to that subject.

2. A paper on "Anthracite Losses" by Dever C. Ashmead, prepared primarily for the U. S. Coal Commission, was published as Bulletin M 8.

3. A detailed study of the culm and silt deposits of the anthracite fields and in the rivers leading from the anthracite fields, to determine the amount, distribution and recovery, both primary and secondary, the quality and use of those materials. This investigation, conducted in 1925-26 by J. D. Sisler, Thomas Fraser, and D. C. Ashmead, was done in cooperation with the Water and Power Resources Board of Pennsylvania and the U. S. Bureau of Mines. The latter made the analyses and tests of the hundreds of samples of coal collected. The results are printed in Bulletin M. 12.

4. The river coal situation was investigated in 1930 by J. M. Hills.

*Bituminous coal:*

1. The sampling of bituminous coals by L. D. Woodworth, E. G. Hill, and J. D. Sisler, and analyses of 755 samples by the U. S. Bureau of Mines, under a cooperative agreement, appeared in Bulletin M 6, Part IV.

2. A computation of the bituminous coal reserves of Pennsylvania by J. F. Reese in 1922, afterwards revised by J. D. Sisler, was published as Bulletin M 6, Part III.

3. A study of bituminous coal losses and mining methods by J. D. Sisler, made in cooperation with the U. S. Coal Commission. The results are printed in Bulletin M 4.

4. A detailed description of the bituminous coal fields of the State by J. D. Sisler. The results were published as Bulletin M 6, Part II, 511 pages, with more than 3,000 sections of coal beds.

5. A general report on coal by the State Geologist, forming Part I of Bulletin M 6. These seven publications on coal cover 1,719 printed pages, thousands of sections of coal beds, and other illustrations and maps.

*Oil and Gas:*

1. A detailed study of the McKeesport gas pool and surrounding area at the time of the discovery of that pool; by the State Geologist.

2. A reconnaissance study of the oil and gas fields of the State by J. F. Robinson; published as Bulletin M 1.

3. A study of the oil to be obtained from the bituminous shales and coals of Pennsylvania, by C. R. Fettke, published as Bulletin M 2.

4. A detailed study by Prof. Fettke of the "sands" met in deep drilling to determine, if possible, criteria for the identification of these sands when brought to the surface.

5. A detailed plane-table study of the Bradford oil field by Prof. Fettke, W. A. Copeland, and Wilbur H. Seifert covering four field seasons; completed in 1930.

6. A somewhat detailed study of all the oil and gas fields of the State; covering three field seasons, by J. D. Sisler, assisted in the office by M. N. Shaffner, F. T. Moyer, and Edward R. Barnsley. The result of this work (1200 pp. MS.) is not yet published but nearing completion.

*Structural materials.* These include studies on the elays, building stones, ganister, flagstones, limestone, molding sands, sand and gravel, and slate.

Clay resources are receiving much attention from the Survey. In 1925 George Longcor sampled fire elays at a number of plants in the State. The collected samples were tested by Prof. J. B. Shaw at State

College. The report on these samples forms Bulletin M 10. In 1927, Prof. Henry Leighton of the University of Pittsburgh began a systematic study of the clays of the State, starting in the southwest corner and proceeding northward and eastward, examining and sampling all clays whether developed or not. These likewise have been tested by Prof. Shaw at the ceramic laboratory at State College. A report on the clays of the Pittsburgh District, including all of the southwest corner of the State, is nearly ready.

The building stones of Pennsylvania have been under study by R. W. Stone since 1924. The report is now nearly completed.

E. S. Moore and T. G. Taylor in 1921 investigated the ganister rocks of Pennsylvania used for making silica fire brick. The deposits were mapped all through central and eastern Pennsylvania, and 65 samples were collected, and tested in the laboratory at State College. The report on Silica Refractories is Bulletin M 3.

The same year Prof. B. L. Miller, of Lehigh University, assisted by Lloyd Fisher and Charles E. Lewall, began a study of the limestones in Pennsylvania for the State Survey. The results of this study were incorporated in Bulletin M 7. The destruction of the reserve stock of this report led to the preparation of a new and much enlarged report on the limestones of the State by Prof. Miller, assisted again by Lloyd Fisher.

In 1919 the threat of an embargo on shipments of limestone for road building purposes led the Highway Department to request the Geological Survey to make a detailed examination of the outcrop of the Vanport limestone in Pennsylvania to locate possible quarry sites. This was done by R. R. Hise, F. B. Peck, B. L. Miller, A. H. Fretz, Charles R. Fettke, and E. G. Hill.

At the request of the American Foundrymen's Association, the Survey undertook the collection of samples of the molding sands of the State. The samples were collected by R. W. Stone and tested in the laboratory at Cornell University. The results are given in Bulletin M 11.

Prof. Freeman Ward, of Lafayette College, in 1927 made a State-wide survey of the sand and gravel resources of the State, and in 1928-29 made detailed studies of supplies of this material in the Scranton, Reading and Altoona districts, as such studies seemed more needed there than elsewhere. Reports in mimeographed form were prepared promptly and distributed in these districts. R. W. Stone has kept in close touch with the bluestone or flagstone industry of northeastern Pennsylvania and wrote mimeographed Bulletin 72 on that subject.

A study of the Pennsylvania slate industry was started in 1923 by Charles H. Behre, Jr., of Lehigh University. In the field seasons 1923-24 he examined the eastern end of the slate area, and prepared Bulletin

M 9 on "The Slate Deposits of Northampton County." Later field studies covered the rest of the slate deposits of the State. A new bulletin covering all of these deposits is now nearly completed.

A bulletin on "Glass Manufacture and Glass Sand Industry of Pennsylvania," by C. R. Fettke prepared as Report XII of the preceding Survey was printed under supervision of the new State Geologist in 1919.

*Metals.* A study of the iron ores of the State was begun by J. Ross Corbin soon after the inauguration of the present Survey. A large amount of data was accumulated by Mr. Corbin with the assistance of R. P. Howell. Magnetic surveys in limited areas failed to lead to the discovery of any new deposits.

Interest in lead and zinc mining in 1923-24 led to the preparation of a bulletin (M 5) on "Lead and Zinc Ores of Pennsylvania," by B. L. Miller. A paper on "Magnetite Deposits at French Creek, Chester County," by Laurence L. Smith has been transmitted for publication. Some attention has been given to the other metallic ores of the State, but not to such an extent as to be recorded in bulletins.

*Non-Metals.* Mr. Stone and H. H. Hughes studied the feldspar deposits of the State in 1927-28. A bulletin on this subject is now in press.

## GROUND-WATER SURVEYS

Since 1926 the State Geological Survey has cooperated with the U. S. Geological Survey in a study of the ground waters of the State. The work has been done entirely by members of the Federal Survey. In 1926 G. M. Hall investigated the area south and east of Kittatinny Mountain in southeastern Pennsylvania; in 1927 A. M. Piper covered the southwest corner of the State and Butler County; in 1928-29 the northwest corner of the State was covered by R. M. Leggette; the northeast corner of the State was surveyed in 1930 by Stanley W. Lohman. The reports of this work are either awaiting publication or nearly ready to be published. The unpublished reports have already proved of large value in solving water supply problems.

## SOIL SURVEYS

Soil surveys have been made of Greene and Adams counties by this Survey in cooperation with the U. S. Bureau of Soils and State College. The work was done by A. L. Patrick, F. G. Merkle, and C. H. Zierdt, all of State College. The soil survey of Adams County was published by the State; that of Greene County by the U. S. Bureau of Soils.



## PERSONNEL

## ADMINISTRATIVE

*Active.* Geo. H. Ashley, State Geologist; Ralph W. Stone, Assistant State Geologist; Lizette F. Carey, Executive assistant; Anna C. Bock, Martha E. Kauffman, clerks; Marie M. Johnstone, draftsman; Marehant N. Shaffner, technical assistant.

*Past.* C. W. Webbert, administrative assistant; Elizabeth B. Garner, Jean M. Raueh, Helen P. Houdeshel, Eleanor M. Bierstein, clerks; O. P. Solem, John G. Hanford, Pearl E. Lewis, Emily P. Flynn, draftsmen; R. Frank Shaffner, technical assistant.

*Past (temporary).* Wm. R. Strawinski, Ruth F. Huller, editorial work; H. A. Allaman, David C. Chidsey, John McCulloch, John D. Martin, Charles C. Milnor.

## GEOLOGIC SURVEYS

*Active.* Geo. H. Ashley, Ralph W. Stone, James D. Sisler (elected State Geologist of West Virginia, July 1, 1930), S. H. Catheart, Bradford Willard, Anna I. Jonas, Charles K. Graeber, associate geologists; Forest T. Moyer, Edward R. Barnsley, assistant geologists.

*Active (cooperating).* Prof. C. R. Fettke, Prof. W. A. Copeland, W. H. Seifert (Carnegie Institute of Technology); J. J. Burke, Harley Gibbs, Prof. Henry Leighton (University of Pittsburgh); Prof. J. B. Shaw, Prof. Frank M. Swartz (State College); Prof. B. L. Miller (Lehigh University); Prof. Freeman Ward, Prof. Harry A. Itter, J. M. Hills (Lafayette College); Prof. F. Bascom (Bryn Mawr College); Prof. Charles H. Behre, Jr. (Lehigh-Northwestern University); Prof. Geo. H. Chadwick (Catskill, N. Y.); Geo. W. Stose, E. O. Ulrich, M. R. Campbell, G. B. Richardson, Charles Butts, O. A. Ljungstedt (U. S. Geological Survey).

*Past.* J. Ross Corbin, (New York City); J. French Robinson (Geologist, Peoples Gas Company); M. E. Johnson (Assistant State Geologist, New Jersey); J. F. Reese (Associate engineer); Herbert H. Hughes (U. S. Bureau of Mines) assistant geologist; Roland W. Brown (U. S. Geological Survey) geologic assistant.

*Past (cooperating or part time).* Olin G. Bell, Prof. C. A. Bonine, Robert B. Bossler, C. J. Campbell, Prof. J. B. R. Dickey, Prof. Henry N. Eaton, Prof. H. L. Fairehild, L. A. Faustino, Lloyd C. Fenstermaehner, Prof. Lloyd W. Fisher, Louis P. Foley, Thomas Frazer, Prof. C. H. Fretz, A. F. Hassan, G. N. C. Hensehen, Richard R. Hiee, Erle G. Hill, Richard P. Howell, Kent K. Kimball, Carl O. Kingsberry, Prof. Charles E. Lawall, Frank Leverett, George Longeor, Prof. F. G. Merkle, Prof. E. S. Moore, Prof. Austin L. Patriek, Roland B. Paxson,



Prof. F. B. Peck, Prof. Wm. A. Price, Jr., B. Coleman Renick, Prof. C. W. Robinson, Prof. H. Justin Roddy, P. S. Schoeneck, Prof. Laurence L. Smith, Lawrence P. Spencer, Thomas G. Taylor, C. W. Webb, Prof. Chester K. Wentworth, Edgar T. Wherry, L. D. Woodworth, Capt. Charles H. Zierdt.

#### TOPOGRAPHIC SURVEYS

In the topographic work from 10 to 15 topographic engineers who are regular employees of the U. S. Geological Survey have been employed each year, and about 35 rodmen holding temporary appointment. The temporary men change from year to year, so that all told several hundred have been employed. At the present time the cost of topographic work is being paid for on the basis of square miles completed, and Federal employees' names do not occur on the Survey payroll.

#### GROUND-WATER SURVEYS

George M. Hall, A. M. Piper, R. M. Leggette, S. H. Lohman, hydraulic engineers, U. S. Geological Survey.

#### FINANCES

It has been the fixed policy of the present Survey from the beginning not to duplicate work being properly done by other organizations or persons, and, wherever possible, to cooperate with such organizations or persons. Almost without exception, the Survey has been met in the same spirit. As a result, the Survey has not established laboratories for work that could be done elsewhere at less cost, and has cooperated with the bureaus of the Federal Government and with colleges of the State as far as possible. This has saved the cost of equipping such laboratories and the overhead expense of laboratory men, for whom there might not be constant employment. In matters requiring the services and judgment of men of highly specialized training, the Survey has asked and received the cooperation of the U. S. Geological Survey and U. S. Bureau of Mines. Both of these organizations have been more than liberal in their cooperative service, and in the loan of their technical men to this Survey. Thus, in the study of coal, the State Survey has collected samples which have been analyzed by the U. S. Bureau of Mines, Pittsburgh, without cost to the State. In the study of clays, the Survey has made the field studies and collected the samples which have been tested at the ceramic laboratory at State College, for a reduced fee. In the same way, laboratories at Carnegie Institute of Technology and other colleges have been used, saving the Survey the expense of maintaining such laboratories for itself.

Cooperation has been established with most of the professors of

geology in the State, by which they have given the Survey the benefit of as much of their time as possible, especially during the summer vacations. Usually these men are able to bring to the Survey, without cost, the results of previous studies made alone or with their students.

The appropriations made since the inauguration of the present Survey are as follows:

### APPROPRIATIONS

1919-1921 Internal Affairs .....	\$100,000	
1921-1923 Internal Affairs .....	150,000	
1923-1925 Internal Affairs .....	4,700	
Forests & Waters .....	105,300	
1925-1927 Forests & Waters .....	135,000	
1927-1929 Internal Affairs .....	135,000	
1929-1931 Internal Affairs .....	150,000	\$780,000

Taking account only of previous bienniums, the expenditures may be summarized as follows:

### *Summary of Expenditures, 1919-1929*

	1919-1921	1921-1923	1923-1925	1925-1927	1927-1929	Total
General operations -----	\$25,515.67	\$41,394.91	\$33,835.97	\$34,306.38	\$30,640.68	\$165,693.61
Administration -----	9,144.54	13,305.14	17,456.23	19,533.08	17,084.91	76,523.90
Information -----	9,579.40	12,824.89	11,980.95	13,574.55	12,242.77	60,202.56
Publication -----	6,791.73	15,264.88	4,398.79	1,198.75	1,313.00	28,967.15
Topography -----	47,998.27	52,376.02	38,466.75	46,387.65	47,256.60	232,485.29
Geology -----	10,498.61	25,680.84	16,875.32	23,336.60	25,287.29	101,678.66
Atlas -----	8,224.64	18,311.51	8,253.02	14,608.09	10,729.28	60,126.54
County reports -----		851.35	628.79	2,697.83	1,135.98	5,313.95
General studies -----	2,273.97	6,517.98	7,993.51	6,030.68	13,422.03	36,238.17
Mineral resources -----	15,975.37	30,548.23	20,794.64	28,944.23	28,314.16	124,576.63
Coal -----	2,080.24	12,500.82	12,253.87	13,929.79	3,602.79	44,367.51
Oil and gas -----	7,723.65	3,441.71	1,136.02	6,046.73	13,090.02	31,438.13
Structural materials -----	4,343.60	7,092.46	3,031.87	5,642.86	11,119.61	31,230.40
Metals -----	1,827.88	7,513.24	4,372.88	3,324.85	97.08	17,135.93
Miscellaneous -----					404.66	404.66
Ground waters -----				2,025.14	3,460.61	5,485.75
Unexpended -----	12.68		27.32		40.66	\$0.06
Total appropriation -----	\$100,000.00	\$150,000.00	\$110,000.00	\$135,000.00	\$135,000.00	\$630,000.00

## APPENDIX A. PRINTED REPORTS

The following are out of print, most of them can be consulted in public libraries:

### MISCELLANEOUS PAPERS

1. The Story of the Survey, by Geo. H. Ashley, 1920, 20 pp. An illustrated brochure containing the history of official geologic work in Pennsylvania and the reasons for the present Survey and its proposed methods of work.
2. The Work of the Survey, by Geo. H. Ashley, 1923, 18 pp., 2 figs. A brochure describing the organization and operation of the Survey.

### BULLETINS AND COUNTY REPORTS

- M 1. The Oil and Gas Fields of Pennsylvania, Vol. 1, Introduction, by Geo. H. Ashley and J. French Robinson. 1922. 79 pp., 4 pls., 9 figs., 1 color map. A condensed, introductory description of the origin, mode of occurrence, and conditions of development of oil and gas, with a brief description of each of the oil and gas pools of the State; also a small scale map of the oil and gas fields.
- M 2. Oil Resources in Coals and Carbonaceous Shales of Pennsylvania, by Chas. R. Fettke. 1923, 119 pp., 6 pls., 16 figs. Describes the petroleum situation, explaining methods of distilling coal and shale, and gives results of tests on 122 samples of coal and shale.
- M 3. The Silica Refractories of Pennsylvania, by E. S. Moore and T. G. Taylor. 1924. 100 pp., 16 pls., 10 figs. Describes the character, distribution, and quarrying of ganister and mica schist, and the properties, manufacture, and uses of silica brick.
- M 4. Bituminous Coal Losses and Mining Methods in Pennsylvania, by James D. Sisler. 1924. 216 pp., 1 pl., 29 figs. Describes the distribution, thickness, character, and reserves of bituminous coal by districts, and indicates the sources of loss and waste at the mines.
- M 5. Lead and Zinc Ores of Pennsylvania, by B. L. Miller. 1924. 91 pp., 5 pls., 7 figs. A description of the distribution, geologic occurrence, and origin of the ores, and a history of mining operations.
- M 6. Part II. Bituminous Coal Fields of Pennsylvania. Detailed description of coal fields, by J. D. Sisler. 1926. 511 pp., 14 pls., inclu., 6 color maps, 152 figs. A report giving details of the bituminous coal beds. The description is by counties.
- M 7. Limestones of Pennsylvania, by B. L. Miller. 1925. 368 pp., 15 pls., inclu. 1 color map, 7 figs. Describes the character, origin, and uses of limestone and the geographic and geologic distribution of the principal deposits. The description of the limestone of each geologic age is arranged by counties.
- M 8. Anthracite Losses and Reserves in Pennsylvania, by Dever C. Ashmead. 1926. 71 pp., 1 pl., 13 figs. This report gives the thickness and acreage of each bed in the anthracite field, the percentage of coal recovered in mining, explains how and why some anthracite is lost, and gives an estimate of the quantity of anthracite remaining in each bed, and in each of the four fields.
- M 9. Slate Deposits of Northampton County by C. H. Behre, Jr., 1927. 312 pp., 36 pls., 49 figs., 2 color maps. Describes the slate quarries in the Bangor, Wind Gap, Portland, Belfast, Chapman, Seemsville, Point Phillip, and Slatefield districts, with special reference to the geologic structure.
- C 1. Adams County Report.

Part II. Mineral Resources, by George W. Stose. 1925. 64 pp., 11 pls. inclu. 1 color map, 1 fig.

III. Soil Survey, by A. L. Patrick and H. H. Bennett. 1924. 44 pp., 1 color map.

A 37. Greensburg Quadrangle, by Meredith E. Johnson. 1926. 162 pp., 13 pls., 25 figs. inclu. 10 color maps.

A 178. New Holland Quadrangle, by Anna I. Jonas and George W. Stose. 1926. 40 pp., 7 pls. inclu. 2 color maps.

The following reports can be obtained on request from the Survey:

M 10. Fire Clays of Pennsylvania, by J. B. Shaw. 1928. 69 pp., 9 figs. This bulletin gives tests of 81 clays collected by the Survey in the fall and winter of 1925, and tested by Professor Shaw in the Ceramics laboratory at State College in 1926.

M 11. Molding Sands of Pennsylvania, by R. W. Stone. 1928. 94 pp., 21 pls., 10 figs. This bulletin describes the molding sands collected by Mr. Stone, and tested in the geological laboratory at Cornell University, at the expense of the American Foundrymen's Association.

A 65. Punxsutawney Quadrangle, by Geo. H. Ashley. 1926. 145 pp., 6 pls. inclu. 5 color maps, 26 figs.

A 206. Allentown Quadrangle, by B. L. Miller. 1926. 195 pp., 15 pls. inclu. 2 color maps, 2 figs.

G 3. Pennsylvania Caves, by R. W. Stone. 1930. 58 pp., 34 figs.

The following can be obtained only from the Bureau of Publications, Department of Property and Supplies, Harrisburg, Pa., at the prices quoted, prepaid:

M 6. Bituminous Coal Fields of Pennsylvania

Part I. General Information on Coal, by Geo. H. Ashley. 1928. 241 pp., 17 pls., 32 figs. 50 cents.

III. Bituminous Coal Resources, by John F. Reese and J. D. Sisler. 1928. 153 pp., 4 pls. This report gives figures showing the coal originally in the ground, coal mined out and lost, and coal remaining and recoverable from each coal bed in each coal county and township in the bituminous coal field. 25 cents.

IV. Analysis of Bituminous Coal. 1925. 268 pp., 1 pl. This report by the U. S. Bureau of Mines gives several hundred measurements and analyses of bituminous coals mined in Pennsylvania. 50 cents.

Map of the Bituminous Coal Fields of Pennsylvania, by J. D. Sisler. (Scale 1 inch equals 6 miles). 50 cents.

M 12. Anthracite Culm and Silt, by J. D. Sisler, Thomas Fraser and Dever C. Ashmead. 1928. 268 pp., 34 pls., 21 figs. This bulletin gives the results of a detailed study of the problems of culm and silt as they affect the anthracite fields of Pennsylvania. The production and uses of anthracite culm and silt are described, the result of detailed studies in silt and culm discharge at the breakers is cited, as well as of the recovery of this coal in the rivers and creeks flowing from the anthracite region. These are followed by the methods and results of sampling culm and silt accumulations in the field, and by computations of the quantity. 50 cents.

A 168. Lancaster Quadrangle, by Anna I. Jonas and George W. Stose. 1930. 103 pp., 23 pls., 10 figs. \$1.00.

A 27. Pittsburgh Quadrangle, by Meredith E. Johnson. 1928. 236 pp., 33 pls. inclu. 4 color maps, 28 figs. \$1.00.

A 5. New Castle Quadrangle, by Frank W. DeWolf. 1929. 238 pp., 18 pls. inclu. 5 color maps, 17 figs. \$1.00.



The following reports are in press:

- M 13. Feldspar in Pennsylvania, by R. W. Stone and H. H. Hughes.
  - M 14. The Magnetite Deposits of French Creek, Chester County, Pa., by Laurence L. Smith.
  - G 2. Syllabus of the Geology and Mineral Resources of Pennsylvania, by Geo. H. Ashley.
- The Resources of Pennsylvania in a Nutshell, by Geo. H. Ashley, 16 pages, 3 x 6 inches. Illustrated circular.
- Geological map of Pennsylvania, 40 by 62 inches.

## APPENDIX B. MIMEOGRAPH BULLETINS

1. Effect of the War on the Price of Coal in Pennsylvania, by Geo. H. Ashley. 1919. 3 pp. (Discontinued)
2. Oil and Gas in Southwest Pennsylvania, by Geo. H. Ashley. 1919. 4 pp. (Discontinued)
3. Development and Probable Life of Gas Pool at McKeesport, Pennsylvania, by Geo. H. Ashley. 1919. 3 pp. (Discontinued)
4. Decline of McKeesport Gas Pool, by Geo. H. Ashley. 1919. 3 pp. (Discontinued)
5. The McKeesport Gas Pool, Allegheny County, Pennsylvania, by Geo. H. Ashley. 1920. 18 pp., 2 maps. (Discontinued)
6. River and Creek Coal in Eastern Pennsylvania, by C. W. Webbert. 1920. 17 pp. (Second edition, 1922). (Discontinued)
7. A High-Grade Building Stone in Greene County, by Geo. H. Ashley. 1920. 2 pp.
8. The Origin of Pennsylvania Coal, by Geo. H. Ashley. 1920. 7 pp. (Discontinued)
9. Future Use of Raw Coal, by Geo. H. Ashley. 1920. 5 pp. (Discontinued)
10. The Possibility of Oil and Gas from Deeper Drilling in Western Pennsylvania, by Geo. H. Ashley. 1920. 5 pp. (Discontinued)
11. Gas Wells on Nine Mile Run, Pittsburgh, Pa., by J. French Robinson. 1920. 2 pp. (Discontinued)
12. Gas Wells on Pollock Run, Westmoreland County, Pennsylvania, by J. French Robinson. 1920. 2 pp. (Discontinued)
13. Natural Gas Situation in Pennsylvania, by Geo. H. Ashley. 1920. 3 pp. (Discontinued)
14. Future Sources of Power, by Geo. H. Ashley. 1920. 3 pp.
15. Mineral Resources of Pennsylvania, by Geo. H. Ashley. 1920. 12 pp. (Replaced by Bulletin 97)
16. Geology of Oil and Gas in Relation to Coal, by Geo. H. Ashley. 1920. 6 pp. (Discontinued)
17. Future of Natural Gas in Pennsylvania, by Geo. H. Ashley. 1920. 4 pp. (Discontinued)
18. Oil from Pennsylvania Shales and Coals, by Chas. R. Fettke. 1921. 15 pp. (Discontinued)
19. Production of the McKeesport Gas Pool, by J. French Robinson. 1921. 12 pp. (ten supplements). (Discontinued)
20. Pennsylvania Iron Ores, by J. Ross Corbin. 1921. 3 pp.
21. Feldspar in Pennsylvania, by Geo. H. Ashley. 1921. 2 pp. (Discontinued)
22. Coal Beds in Southern Somerset County, Pennsylvania, by J. D. Sisler. 1921. 16 pp. (Discontinued)
23. Coal Beds in Cambria County, Pennsylvania, by J. D. Sisler. 1922. 13 pp. (Discontinued)
24. Coal Beds in Greene County, Pennsylvania, by J. D. Sisler. 1922. 6 pp. (Discontinued)
25. Coal Reserves in Greene County, Pennsylvania, by John F. Reese. 1922. 6 pp. (Discontinued)
26. Coal Beds in Washington County, Pennsylvania, by J. D. Sisler. 1922. 8 pp. (Discontinued)
27. Coal Reserves in Washington County, Pennsylvania, by John F. Reese. 1922. 6 pp. (Discontinued)
28. Magnesite in Pennsylvania, by R. W. Stone. 1922. 3 pp.
29. Geologic Structure of the Greensburg Quadrangle, Pennsylvania, by M. B. Johnson. 1922. 3 pp., 1 map. (Discontinued)

30. Coal Beds in Allegheny County, Pennsylvania, by J. D. Sisler. 1922. 9 pp. (Discontinued)
31. Coal Reserves in Allegheny County, Pennsylvania, by John F. Reese. 1922. 5 pp. (Discontinued)
32. Coal Beds in Fayette County, Pennsylvania, by J. D. Sisler. 1922. 13 pp. (Discontinued)
33. Coal Reserves in Fayette County, Pennsylvania, by John F. Reese. 1922. 5 pp. (Discontinued)
34. Coal Beds in Westmoreland County, by J. D. Sisler. 1922. 15 pp. (Discontinued)
35. Coal Reserves in Westmoreland County, Pennsylvania, by John F. Reese. 1922. 5 pp. (Discontinued)
36. Coal Beds in Indiana County, Pennsylvania, by J. D. Sisler. 1922. 11 pp. (Discontinued)
37. Coal Reserves in Indiana County, Pennsylvania, by John F. Reese. 1922. 5 pp. (Discontinued)
38. Coal Beds in Armstrong County, Pennsylvania, by J. D. Sisler. 1922. 12 pp. (Discontinued)
39. Coal Reserves in Armstrong County, Pennsylvania, by John F. Reese. 1922. 5 pp. (Discontinued)
40. White Clay Deposits at Saylorsburg, Monroe County, Pa., by Frederick B. Peck. 1922. 7 pp., 1 map.
41. Coal Beds in Elk County, Pennsylvania, by J. D. Sisler. 1922. 5 pp. (Discontinued)
42. Coal Beds in Jefferson County, Pennsylvania, by J. D. Sisler. 1922. 10 pp. (Discontinued)
43. Coal Reserves in Somerset County, Pennsylvania, by John F. Reese. 1922. 12 pp. (Discontinued)
44. Coal Reserves in Cambria County, Pennsylvania, by John F. Reese. 1922. 5 pp. (Discontinued)
45. White Clay Deposits in Central Pennsylvania, by E. S. Moore. 1922. 6 pp., 1 map.
46. Coal Beds in Butler County, Pennsylvania, by J. D. Sisler. 1922. 5 pp. (Discontinued)
47. Manganese Occurrences in Eastern Pennsylvania, by Benjamin L. Miller. 1922. 11 pp.
48. Pyrite from Bituminous Coal Mines in Pennsylvania, by Henry Leighton. 1922. 19 pp., 3 pls., 1 map.
49. Coal Beds in Clarion County, Pennsylvania, by J. D. Sisler. 1922. 7 pp. (Discontinued)
50. Coal Beds in Centre, Cameron, Clinton, and Lycoming Counties, Pennsylvania, by J. D. Sisler. 1922. 8 pp. (Discontinued)
51. New Oil Pool at Tidioute and Gas Pools near Corry and Meadville, Pa., by M. E. Johnson. 1922. 4 pp., 1 map.
52. Coal Beds in Mercer, Crawford, Venango, Forest, Warren, McKean, Potter, Tioga, and Bradford Counties, Pennsylvania, by J. D. Sisler. 1922. 10 pp. (Discontinued)
53. Coal Reserves in Clearfield County, Pennsylvania, by John F. Reese. 1922. 6 pp. (Discontinued)
54. Bituminous Coal Reserves in Pennsylvania, by John F. Reese. 1922. 9 pp. (Discontinued)
55. Coal Beds in Lawrence County, Pennsylvania, by J. D. Sisler. 1922. 3 pp. (Discontinued)
56. Oil Fields Rejuvenated, by Robert B. Bossler. 1922. 14 pp.
57. Coal Beds in Beaver County, Pennsylvania, by J. D. Sisler. 1921. 4 pp. (Discontinued)
58. Potash Fiasco in Tioga County, Pa., by R. W. Stone; and Simple Tests for Potash, by W. B. Hicks. 1922. 7 pp.

59. Bog Iron Ore, by J. Ross Corbin. 1922. 5 pp.
60. Geologic Structure of the Pittsburgh Quadrangle, Pa., by M. E. Johnson. 1923. 4 pp., 1 map. (Discontinued)
61. Magnetite in Pennsylvania, by J. Ross Corbin. 1923. 6 pp., 1 map, 1 chart.
62. Rocks of McCalls Ferry Quadrangle, Pa., by Anna I. Jonas. 1923. 6 pp., 1 map.
63. Brown Iron Ores in Pennsylvania, by J. Ross Corbin. 1923. 7 pp., 1 map, 2 charts.
64. Coal Beds in Southern Somerset County, Pennsylvania, by J. D. Sisler. 1923. 20 pp. (Discontinued)
65. Lead and Zinc Ores in Blair County, Penna., by Benjamin LeRoy Miller. 1923. 4 pp. (Discontinued)
66. Oil and Gas Development in Pennsylvania in 1922, by M. E. Johnson. 1923. 4 pp.
67. Lead and Zinc Ores near Phoenixville, Chester County, Pennsylvania, by Benjamin LeRoy Miller. 1923. 12 pp. (Discontinued)
68. Lead and Zinc Ores in Lancaster County, Pennsylvania, by Benjamin LeRoy Miller. 1923. 3 pp. (Discontinued)
69. Lead and Zinc Ores in Bucks County, Pennsylvania, by Benjamin LeRoy Miller. 1923. 4 pp. (Discontinued)
70. Zinc Ores at Friedensville, Lehigh County, Pa., by Benjamin LeRoy Miller. 1923. 7 pp. (Discontinued)
71. Copper Ores in Pennsylvania, by J. Ross Corbin. 1923. 8 pp.
72. Flagstone Industry in Northeastern Pennsylvania, by R. W. Stone. 1923. 7 pp.
73. Oil and Gas Sands in the North Half of the Pittsburgh Quadrangle, Pa., by M. E. Johnson. 1923. 10 pp. (Discontinued)
74. Chromite in Pennsylvania, by J. Ross Corbin. 1923. 7 pp.
75. Rocks of the Quarryville Quadrangle, Pa., by Anna I. Jonas. 1923. 9 pp., 1 map. (Discontinued)
76. Calcareous Marl in Pennsylvania South of the Terminal Moraine, by J. B. R. Dickey. 1923. 10 pp., 3 figs.
77. Gold in Pennsylvania, by J. Ross Corbin. 1923. 13 pp.
78. Gas in Leidy Township, Clinton County, Pa., by Meredith E. Johnson. 1923. 17 pp., 3 maps.
79. Tidionte Oil Pool, Warren County, Pa., by Meredith E. Johnson. 1923. 17 pp., 3 maps.
80. Coal Beds in Northern Somerset County, Pennsylvania, by J. D. Sisler. 1923. 28 pp. (Discontinued)
81. Volatile Matter in Pennsylvania Coals, by J. D. Sisler. 1923. 11 pp. (Discontinued)
82. Roofing Granules Industry in Southeastern Pennsylvania, by R. W. Stone. 1923. 4 pp.
83. The Living Earth, by Geo. H. Ashley. 1924. 4 pp.
84. Coal Reserves in Clarion County, Pennsylvania, by J. D. Sisler. 1924. 10 pp. (Discontinued)
85. Coal Reserves in Jefferson County, Pennsylvania, by J. D. Sisler. 1924. 11 pp. (Discontinued)
86. The Age and Origin of the Earth, by Geo. H. Ashley. 1924. 8 pp.
87. Molding Sands in Pennsylvania, by R. W. Stone. 1925. 20 pp. (Discontinued)
88. Silurian Stratigraphy at Lehigh Gap, Pennsylvania, by Geo. H. Ashley. 1925. 6 pp.
89. A Practical Classification of Coals, by Geo. H. Ashley. 1926. 16 pp.
90. Pennsylvania, The Makings of a World Power, by Geo. H. Ashley. 1926. 23 pp.



91. A Stratigraphic Time Scale, by Geo. H. Ashley. 1927. 10 pp.
92. Anthracite Culm and Silt, by J. D. Sisler. 1928. 9 pp. (Discontinued)
93. The Canadian System, by Geo. H. Ashley. 1928. 10 pp. (Technical)
94. High Spots in Pennsylvania, by Geo. H. Ashley. 1928. 8 pp.
95. Mineral Resources of the Lower Allegheny and Beaver River Districts, by Geo. H. Ashley. 1928. 6 pp.
96. Sand and Gravel in the Scranton Region, Pennsylvania, by Prof. Freeman Ward. 1928. 15 pp.
97. Mineral Resources of Pennsylvania, by Geo. H. Ashley. 1928. 9 pp.
98. Mineral Resources of the Pittsburgh District, by Geo. H. Ashley. (Not written yet).
99. Sand and Gravel in the Reading Region, Pennsylvania, by Prof. Freeman Ward. 1929. 13 pp.
100. Sand and Gravel in the Altoona Region, Pennsylvania, by Prof. Freeman Ward. 1930. 15 pp.

## APPENDIX C. PAPERS IN TECHNICAL JOURNALS

Among papers prepared for outside publication may be noted the following.

BY GEO. H. ASHLEY

- A Use Classification of Coal: Am. Inst. Min. & Met. Eng. Bull. 152, Aug., 1919.  
A Glance into the Future (Coal and Power): Electrical World, vol. 74, No. 18, pp. 942-944, Nov. 1919.  
A Use Classification of Coal, with maps: Coal Age, Dec. 23, 1919.  
The New Geological Survey of Pennsylvania: Proc. Coal Min. Inst. of Am. for 1919.  
Pennsylvania Coal and the Grand Push: Coal Age, vol. 17, No. 26, pp. 1307-1310, June 24, 1920.  
The Geology of Oil and Gas: Proc. Coal Min. Inst. of Am. for 1920.  
The Mineral Resources of Pennsylvania: Proc. of Engineer's Society of Western Pennsylvania, vol. 37, No. 1, pp. 1-17, February, 1921.  
The Mineral Resources of Pennsylvania: Proc. Coal Min. Inst. of Am. for 1921.  
Correspondence of Coals of Appalachian Coal Fields: Coal Industry, Mar. 1922.  
A Practical Classification of Coals: Proc. Coal Min. Inst. of Am. for 1923, pp. 29-40.  
Pennsylvania's Prehistoric Vegetation furnished her Power Today: Forest Leaves, p. 69, Oct. 1925.  
Pennsylvania's Scenery: Outdoors Pictorial, pp. 29-30, Apr. 1926.  
Memorial of Richard R. Hice: Geol. Soc. of Am., vol. 37, pp. 94-96, 1926.  
The Pittsburgh Coal Bed in Pennsylvania: Am. Inst. of Min. & Met. Eng., 1926.  
The Pittsburgh Coal Bed: Am. Inst. of Min. & Met. Eng., 1926.  
A Catechism of Interesting Facts about Coal: Proc. Coal Min. Inst. of Am. 4th meeting, p. 66, 1926.  
Progress in Coal Classification: Combustion, p. 168, Sept. 1927.  
The Outlook for Fuel Oil: Combustion, pp. 163-4, Sept. 1927.  
Petroleum Production, Past, Present and Future: Penn State Engineer, pp. 5, 6, 24-28, Oct. 1927.  
Recent Findings in Susquehanna Valley History: Am. Assoc. for Advancement of Science, Abstract, 1927.  
Geology and the World at Large: Science, pp. 21-24, Jan. 13, 1928.  
The Rocks of Pennsylvania and the Story they Tell: Pa. School Jour., (serial) Dec. 1927 to May 1928.  
The Lost Coal of Pennsylvania: Proc. Coal Min. Inst. of Am., pp. 122 and 123, 1928.  
The Outlook for Coal: Min. Congress Jour., pp. 101-105, Feb. 1929.  
Ten Years' Development in Heating Practice: Eng. and Finance, vol. XXI, No. 1, p. 30, July. 1929.  
The Age of the Appalachian Peneplains: Proc. Geol. Soc. of Am., 1929.  
The Case of Coal: Combustion, pp. 24-27, June, 1930.  
Coal Classification: Am. Inst. of Min. & Met. Eng., 1930.  
Barrier pillar Legislation in Pennsylvania: Am. Inst. of Min. & Met. Eng., 1930.

BY R. W. STONE

- Magnesite Deposits Examined in Pennsylvania: Eng. & Min. Jour., vol. 113, No. 7, p. 288, Feb. 18, 1922.

- Decorative Flagstone: Stone, vol. XLIV, No. 11, pp. 635-636, Nov. 1923.
- What State Geological Surveys are Doing for Rock Products. Help Land-owners and Producers to solve Economic Problems: Rock Products, vol. XXVII, No. 4, pp. 27-28, Feb. 23, 1924.
- Source of the Limestone Quarryman's Profit: Rock Products, vol. 27, No. 8, pp. 25-26, April 19, 1924.
- Rock Slides Once Waste—Now Valuable. Present values of ganister deposits and their development: Rock Products, vol. XXVIII, No. 6, pp. 31-32, March 21, 1925.
- Granite in Pennsylvania: Stone, vol. XLVI, No. 4, pp. 223-224, April, 1925.
- Rock Dust Industry, Berks County, Pennsylvania: Rock Products, vol. XXVIII, No. 9, p. 42, May 2, 1925.
- The Durability of Building Stone: Stone, vol. XLVII, No. 5, pp. 293-294, May, 1926.
- Pennsylvania Building Stones: Proc. Penna. Acad. Sci., vol. I, p. 100, 1926.
- Black Granite of Northern Bucks County, Pennsylvania: Proc. Penna. Acad. Sci., vol. 1, p. 63, 1926.
- Pennsylvania Building Stone: Stone, vol. XLIX, No. 1, pp. 34-35, Jan., 1928: vol. XLIX, No. 2, pp. 109-110, Feb., 1928.
- Roofing Granules Industry in Southeastern Pennsylvania: Rock Products vol. XXXI, No. 25, pp. 26-31, Dec. 8, 1928.
- Asymmetrical Drainage in Southwestern Pennsylvania: Proc. Penna. Acad. Sci., vol. II, pp. 34-37, 1928.
- Feldspar in Pennsylvania: Rock Products, vol. XXXII, No. 2, pp. 42-46, Jan. 19, 1929.
- Old Pennsylvania Marble Quarry now operated as a Whiting Mine: Pit and Quarry, vol. XVIII, No. 12, pp. 59-61, Sept. 11, 1929.
- Pennsylvania Caves: Lancaster Motorist, October, 1929.
- Crushed Sandstone for Railroad Ballast: Rock Products, vol. XXXII, No. 26, pp. 50-52, Dec. 21, 1929.
- Underground Fairyland in Pennsylvania: Lancaster Motorist, April, 1930.
- Caves Developed by Explosives: Explosives Engineer, vol. 8, No. 6, pp. 214-215, June, 1930.

#### BY J. D. SISLER

- Pennsylvania's Present and Future Natural Gas Production: Natural Gas, vol. XI, No. 3, p. 22, 1930.
- Pennsylvania Grade Petroleum and its Products: The Purchasing Agent, vol. XIX, No. 3, p. 253, 1930.
- The Natural Gas Industry Builds for the Future: Public Utility Purchasing, vol. II, No. 4, 1930.

As representative of the type of stories written for the newspapers the following might be listed:

#### BY GEO. H. ASHLEY

- Meaning of Coal Mining in the life of Pennsylvania.
- All's not Coal that's Black.
- Harrisburg and its River.
- Topographic Maps.
- Oil in Southeastern Pennsylvania.
- Oil and Gas Future.
- Interesting Facts about Pennsylvania.
- Pennsylvania's Place in the Sun.

Pennsylvania's **H**ighest Mountains.  
 Review of work of the Bureau.  
 Why Ore Discoveries in Pennsylvania are Doubtful.  
 How come the Water Gaps of Pennsylvania.  
 What we don't know about Pennsylvania.  
 Knocking the Prospector or Guarding the Investor.  
 Pennsylvania is Surveying its Resources.  
 Is your Town Looking Backward?  
 Pennsylvania the Marketing Center of the Nation.  
 Pennsylvania not in an Earthquake Belt.  
 Only a Matter of Time.  
 The Mountain Upside Down.  
 The Makings of an Empire.  
 How Old is Man?  
 If Pennsylvania had had no Coal.









